Journal of the Indian Fisheries Association
18, 1988 97-101

RECENT ADVANCES IN TROPICAL FRESHWATER AQUACULTURE

T.J. VARGHESE

Professor of Aquaculture, University of Agricultural Sciences,
College of Fisheries, Mangalore 575 002.

ABSTRACT

Several technological advances have been made in tropical freshwater aquaculture during the last three decades. Hatchery production of carp seed was achieved in India and China towards the late 1950's. Channel catfish farming in the United States has made a phenomenal growth during the last three decades. Development of the technology of high density culture using artificial aeration and nutritionally balanced diet has revolutionised freshwater aquaculture, particularly in Israel. Culture of fishes in cages, pens and running water helped to achieve very high productions. Considerable research work has been done on fish nutrition during recent years. Investigations on sex control have revealed that it is possible to produce a single sex progeny which is more desirable for culture. The freshwater bodies, which cover less than 2% of the earth's surface, will become an important source of fish production in the near future.

INTRODUCTION

Out of the 85 million tons of fish produced annually in the world, about 11% are obtained from aquaculture. China leads the world in freshwater aquculture followed by India. The average rate of production from freshwater aquaculture has been steadily increasing in all countries of the world. Concerted research efforts on warmwater aquaculture have been made only during the last three decades. Still, the technology is much less developed when compared to coldwater aquaculture despite the fact that warmwater environment offers much greater scope for productivity. Development of warmwater

aquaculture is more important since most of the developing countries are located in the tropical regions of the world. Investigations on problems of warmwater aquculture have been mostly conducted in the United States of America, Israel, Japan, China and India. The common carp, Chinese and Indian major carps, tilapias and channel catfish are the most intensively investigated species. Some of the recent advances made in the culture technology of these species are discussed in this article.

HATCHERY PRODUCTION OF FISH SEED

Production of quality fish seed under controlled conditions is an essential prerequisite for successful aquaculture. The technique of induced spawning of fish through hormone treatment was first developed by Brazilian biologists in 1934. However, this technique has found wider application in Asia, Europe, and North America. While Indian scientists achieved the first success in induced breeding of Indian major carps through hypophysation in 1957, the Chinese succeeded withChinese carps in 1958. Since then, this technique was highly refined and extended to different fish seed production forms in India and China. Presently China mainly depends on this technique for fish seed production, whereas India produces about 10% of carp seed employing this method. Development of the Chinese hatchery has greatly facilitated commercial scale carp seed production. Recent findings that it is possible to extend the breeding season of major carps as well as to obtain multiple spawnings of a brood fish during a spawning season by monitoring water parameters and nutrition will go a long way in helping to bridge the gap between carp seed requirement and production.

CATFISH FARMING IN U.S.

A significant development in freshwater aquaculture in the recent years is the rapid expansion of catfish culture industry in the United States. Catfish production has increased from a few thousand kg in 1963 to over 80 million kg in 1983. By far the most important species cultured is the channel catfish, *Ictalurus punctatus*. This species has several desirable qualities for culture. It can be easily spawned, readily accepts artificial diets, grows fast, tolerates crowding, the flesh retains high quality after processing and has esteemed flavour. Annual production of channel catfish ranges from 3000 to 6000 kg/ha. About 50,000 ha of ponds are under catfish farming in the U.S. today of which 50% are located in Mississippi. Continuous research on seed

production, genetic improvement, nutrition and water quality management has resulted in increased rate of production. More than 50% of the fish produced is marketed as frozen fish. In 1983, 63 million kg of catfish were frozen and marketed. The frozen fish was sold at a rate of $ 3.65 per kg. Catfish farming has become a major industry in southern U.S.

HIGH DENSITY CULTURE

Countries with limited freshwater resources, like Israel, are constantly striving to develop technologies for increasing the rate of fish production. Oxygen content of pond water is the most important limiting factor for increasing the production rate. Experiments conducted in Israel since 1971 have proved that fish production from stillwater ponds can be increased 5-6 folds by artificially aerating the ponds. Ponds under aeration are stocked at a high density of 40-50 thousand fingerlings per ha and fed regularly with nutritionally balanced artificial diets. The species used for high density culture in Israel are common carp, silver carp, *Tilapia aurea*, *Mugil cephalus* and *M. capito*. Of late, the giant freshwater prawn, *Macrobrachium rosenbergii* is also introduced in the polycylture ponds. These ponds under high density culture have produced 20,000 to 45,000 kg of fish/ha in 200 days, which is the growing period in Israel. Ponds under aeration have yielded 15,000 to 25,000 kg/ha/year in China. The Orion Chemicals and Distillaries in Madras has demonstrated that it is possible to achieve a fish production of 50 t/ha/year by culturing all male fingerlings of a tilapia hybrid. The organically rich effluent from the distillery is first broken down by anaerobic bacteria producing methane gas in the process. The digested effluent is further treated aerobically producing protein-rich bluegreen algae and microfauna. The digested water containing various kinds of microorganisms are led into the tilapia ponds. Apart from the natural food, fish are also fed with specially formulated diet to maintain the growth rate. The pond water is continuously aerated using paddle-wheel aerators. In about six months, tilapia fingerlings reach the marketable size of 450 to 500 g.

Cage culture and running water culture of common carp in Japan and channel catfish in the United States are based on the principle of quick removal of fish metabolites from the culture environment since it has been proved that metabolites of fish are the main growth inhibitors in stillwater ponds. In both the above systems, fish are fed 4-5 times daily since they depend entirely on artificial feeds for nutrition. While the running water

ponds of Japan give an average production of 20 t/ha/year, production from cages works out to 200 to 400 t/ha/year.

FISH NUTRITION

During the last three decades, no other aspect of aquaculture has received as much attention as fish nutrition. Nutritional studies on warmwater fishes were started with investigations on channel catfish in the Unites States and common carp in Japan. Presently, the nutritional requirements of, at least, a few cultured fishes are known. Some 40 chemical compounds have been shown to be necessary for normal metabolism of many fishes. Based on this information efficient practical diets have been developed for aquaculture. Though the protein requirement of fish diet is 30-35%, increase in lipid content or carbohydrate content could bring down the protein level through protein-sparing action. A good feed for carps should contain 3 k cal of metabolizable energy per gramme. Efficiency of feeding can be increased by use of automatic or demand feeders. It has been possible to improve the conversion efficiency of diets by adding different growth inducers. In recent experiments conducted in India, it was seen that the rate of growth of major carps could be increased over 40% by incorporating 17 α-methyltestosterone or diethylstilbestrol at 1-3 ppm level in the diet.

SEX CONTROL

Monosex culture is necessary in prolific spawners, like tilapias, to avoid the problem of over-population as well as in species where a particular sex has desirable traits. In tilapias, the male grows faster than the female. Thus, in these species monosex culture gives faster growth and eliminates reproduction. It has been possible to get monosex broods through hybridization or sex reversal. A cross between female *Oreochromis mossambicus* and male *O. hornorum* has produced all male progeny. Five other crosses reported to produce all male hybrids are *O. niloticus* X *O. hornorum*, *O. niloticus* X *O. macrochir*, *O. niloticus* X *O. aureus* and *O. niloticus* X *O. variabilis* and *O. spilurus* X *O. hornorum*. The use of hormones for production of monosex broods has proved effective in several species. In several cases, dietary administration of methyltestosterone or diethylstilbestrol has produced male or female dominated populations respectively. The hormone treatment is given to hatchlings for only 30-40 days. The success of sex reversal treatment depends on the kind and dosage of steroid used, the method of administration,

time and duration of treatment and the species treated. In recent experiments conducted in India, it was possible to produce sterile broods of common carp and tilapia through hormone treatment. The sterile fish was found to grow much faster than the normal ones since no energy is utilised for development of gonads in the former.

CONCLUSION

Freshwater aquaculture is fast developing in several countries of the world. The average rate of fish production from freshwater aquaculture has increased from 1.5 to 4 t/ha/year in Israel during the last two decades. Channel catfish production in the U.S. has registered several fold increase during the corresponding period. There has been a rapid increase in the production of cultured carps in China. In India, apart from a significant increase in production from the traditional carp ponds of West Bengal, several farmers in other states have taken up fish culture. In the peripheral regions of Kolleru lake in Andhra Pradesh, about 25,000 ha of fish ponds have been constructed during the last 15 years. In the next couple of decades, the freshwater bodies of the world, covering less than 2% of the earth's surface, will become an important source of food production.